Department of Natural Resources
Fisheries Branch

An Assessment of the Lake Trout Stock in Clearwater Lake, 1979

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MS Report #83-33

1983

MG-8159

Leroux, D. 1983.
An Assessment of the Lake Trout Stock in Clearwater Lake, 1979.
Manitoba Department of Natural Resources, MS Report No. 83-33 , 31 pp.

ABSTRACT

A lake trout stock assessmen[illegible] Clearwater Lake was conducted in July and August of 1979 with additional data also collected in 1981. The study was initiated in response to resource user concern expressed regarding the status of the lake trout population.

Results of the study indicate that lake trout stocks in Clearwater Lake are healthy, however older larger fish are not well represented in the population. The lake trout exhibited slow growth, late age of maturity and individuals may not spawn each year.

The present exploitation is keeping recruitment of trophy size fish to a minimum therefore Clearwater Lake will likely never recover to a trophy status without rigid restrictions on harvest rates. Present fishery based development would make such restrictions unrealistic.

A review of management strategies and a moratorium on further fisheries based development is recommended to protect the present high quality lake trout fishery.

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INTRODUCTION

Clearwater Lake is one of the principal recreation areas in The Pas region and maintains a high publc profile. It is unique for the area due to its depth and water clarity. Located 25 kilometers north of The Pas, Clearwater Lake presently supports 349 private cottages, three lodges, three campgrounds and three day use picnic areas. Pioneer Bay, Campers' Cove and Hugo Bay campgrounds have 17, 40 and 105 unserviced lots respectively. Although fishing is a major attraction, Clearwater Lake is also used as a summer and winter recreational area for various forms of outdoor activities.

In addition to the recreational aspects of Clearwater Lake, it provides a valuable source of lake trout, *Salvelinus namaycush* , and whitefish, *Coregonus clupeaformis* , spawn for the Fisheries Branch hatcheries. The eggs are used for stocking in Manitoba and have been traded with other provinces and states in return for eggs and fry of other species not available in the province.

The present study was initiated in 1979 as a result of concern expressed by lodge and cottage owners and various organizations over the status of the lake trout population. An attempt was made to duplicate Schlick's (1978) set locations and dates from the 1970 study for comparison purposes. Analysis of the data collected in 1979 (present study) indicated the need for a larger sample size to gain more confidence

in the biological parameters examined for lake trout, therefore an additional 150 lake trout samples were collected in 1981 to supplement the data.

THE FISHERY

The 1980 sport fishing survey indicated that the Northwest Region receives the greatest number of angling days by non-residents in comparison to the rest of the province. Resident angling also forms a significant portion of the area's angling and accounts for almost all the winter angling. Lake trout appear to rank third behind walleye and pike in the species preferred and sought after. The survey indicated that a size of 3.5 kilograms was considered by anglers to be quality fishing while a lake trout in excess of 9.0 kilograms was a trophy.

At the present time, the main attraction for anglers in Clearwater Lake is the lake trout, one of the most southerly natural populations in Manitoba. Several trophy size trout are still taken each year from both the summer and winter recreational fishery. The trout are taken during open water by trolling with large spoons or jigging with large baited bucktail jigs. Spoons and jigs are also used during the winter angling. The angling is concentrated in the shallow inshore areas in the spring and fall, and primarily in a few known deep holes during the summer months as the trout seek colder water. In more recent years, the use of echo sounders to locate the holes has significantly increased angler success during the summer months.

Past records indicate that Clearwater Lake was commercially fished during the winter season from 1931 to 1944. Concern for the lake trout populations initiated the closing of this fishery in 1944. In recent years, several attempts have been made to utilize the whitefish captured in the trapnets during the spawn taking operations, however logistical problems have hampered the success of this commercial operation.

THE STUDY AREA

The following description is taken from Weir (1960) and Schlick (1978). Clearwater Lake (54 05'N, 101 00'W) is situated in a Silurian-Ordovician formation 20 kilometers north of The Pas, Manitoba. (Figure 1). The surrounding natural vegetation is typically a northern coniferous forest type with predominantly black spruce. The lake is approximately 16 kilometers long and 16 kilometers wide with an area of 28,874 hectares. The west portion of the lake slopes gradually to a depth of 12 meters after which the lake bottom becomes irregular. In general, the eastern side of the lake slopes much quicker to a depth of 12 meters. There are four distinct areas where the lake is deeper than 30 meters and the maximum recorded depth is 38 meters. The mean depth of Clearwater Lake is 13.2 meters.

The Clearwater watershed is limited to an area of a few kilometers from the lake shoreline. A number of small seasonally flowing streams enter Clearwater Lake on its west side, draining from the end moraine and

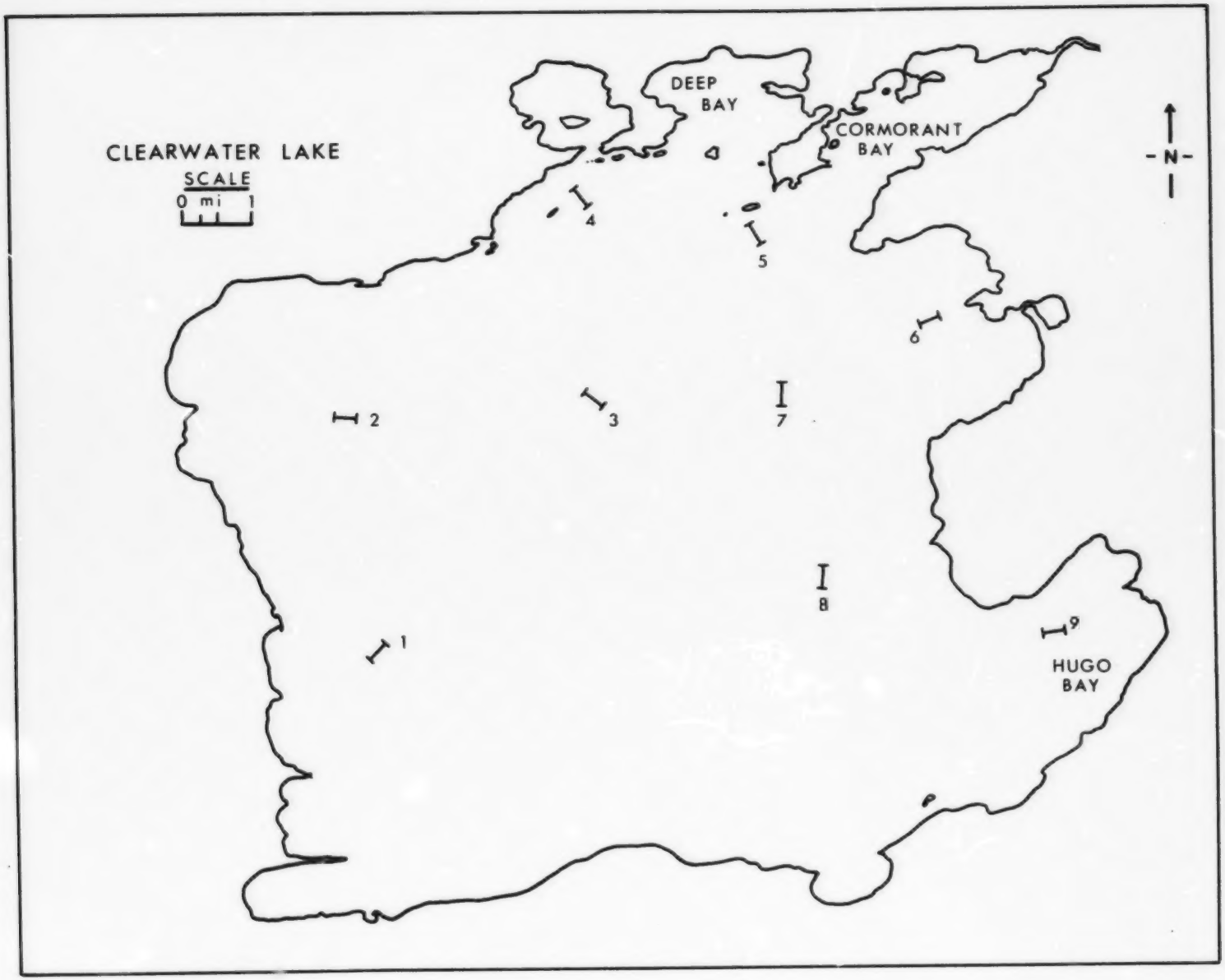

Fig. 1. Map of Clearwater Lake showing the location of experimental nets, 1979.

muskeg to the west. Water flows out of Clearwater Lake via the northeast corner and flows into Cormorant Lake.

MATERIALS AND METHODS

The study was conducted between July 23 and August 15 in 1979. Standard gangs composed of 45.7 meters each of 77 mm, 96 mm, 108 mm, 121 mm and 133 mm mesh (stretched measure) gillnets were set in nine loctions (Figure 1). Three additional sets were made between July 7 and 26, 1981, duplicating set numbers 3,7 and 8 to obtain further lake trout samples. Dates and locations of sets from 1970 were duplicated from Schlick (1978) for comparison purposes. Time of set and lift as well as depth were recorded for each set. The average set time was 20 hours (range 12 - 27 hours).

Lake trout, whitefish and northern pike, *Esox lucius* , were sampled for fork length (to the nearest 1 mm), round weight (to the nearest 10 g), sex and stomach contents during the 1979 portion of the study. Only lake trout were sampled in 1981.Pelvic fins and scales were collected from whitefish and northern pike, while otoliths were taken from lake trout for age determination. The structures were stored in envelopes marked with the sample information for later age determination. A total count by set and mesh size was made of all remaining species.

Otoliths and fins were mounted in epoxy, sectioned and mounted on a microscope side. The annuli were then counted on an image produced by a

microprojector.

Length-weight relationships were determined by the following power equation:

$\log_e W = a + b \ (\log_e L)$

where w = weight in grams

a = y - intercept

b = slope of regression line

L = fork length in millimeters

The condition factors (CF), which indicate a relative measure of robustness, were calculated for each fish from the formula:

$CF = \text{Weight} \times 10^5 / \text{Length}^3$

Survival rates were calculated using both a regression model and the methods outlined by Robson and Chapman (1961) for the analysis of a segment of a catch curve.

The bathymetric map was compiled from Schlick's (1978) study. Morphometric data were taken from this survey for use in calculating the maximum sustainable yield (MSY). Ten water samples were collected in July 1982 to determine a mean filterable residue value for Clearwater Lake.

The morphoedaphic index (MEI) and maximum sustainble yield were calculated according to Ryder's (1965) formula for moderate to intensively fished lakes. The regression formula for calculating the MSY is as

follows:

$$MSY = 1.383 (MEI^{.47441})$$

Data from the morphometric calculations were converted to metric units for application in the above formula.

RESULTS

In the following sections, the total catch is described in terms of catch by mesh size, species composition and relative abundance. Biological data are summarized for lake trout and presented in graphical and tabular form. For comparative purposes in terms of catch data, only data collected from the 1979 netting are used. The data collected from the three additional sets made in 1981 are used only in the biologial data presented for lake trout.

CATCH

A total of 988 fish were caught in nine sets during the 1979 study (Table 1). Details on the catch and catch per unit effort for each species by mesh size are given in Table 2. Six species were represented in the total catch of which rough fish (burbot and suckers) made up 31 percent. The catch of northern pike was insignificant, comprising only three percent of the total catch. Lake whitefish were the most numerous species, representing 50 percent of the total catch. Since both the 1970 and 1979 surveys were primarily interested in lake trout the location of

TABLE 1. Total catch for each species by set location from experimental nets, Clearwater Lake, 1979.

Species	Set Location									Total
	1	2	3	4	5	6	7	8	9	
	No.	No.	No.	No.	No.	No.	No.	No.	No.	
Lake trout *(Salvelinus namaycush)*	11	13	41	-	14	2	43	31	3	158
Whitefish *(Coregonus clupeaformis)*	48	34	89	-	101	-	130	90	4	496
Northern pike *(Exos lucius)*	-	-	-	19	-	6	-	-	2	27
White sucker *(Catastomus commersoni)*	46	54	-	32	-	34	-	-	40	206
Longnose sucker *(Catastomus catastomus)*	29	19	11	-	11	15	2	1	-	88
Burbot *(Lota lota)*	1	2	1	-	1	-	1	7	-	13
Total	135	122	142	51	127	57	176	129	49	988

the sets were mainly in lake trout areas. This undoubtably influenced the relative abundance (% composistion) of the catch but the diversity of species present in the catch is thought to be representative of the lake. Details on the set locations are given in Table 3.

The overall catch per unit effort was 56.6 fish per 100 meters per 24 hours. The catch per unit effort for lake trout was 9.0 (Table 2). The nets set in locations with depths in excess of 20 meters caught more fish and in particular, more lake trout. The 96 mm mesh size proved the most effective for lake trout with a catch per unit effort of 12.1 while the 77 mm mesh size had the highest catch per unit effort for all species.

LAKE TROUT

A total of 295 lake trout were analyzed; 150 from the 1979 survey and 145 additional trout from the 1981 netting to supplement the sample size.

Length-weight Relationship

The length-weight relationship for lake trout from Clearwater Lake is shown as follows:

$$\log_e \text{Weight} = -13.1232 + 3.2826 (\log_e \text{Length})$$

The mean condition factor for Clearwater Lake lake trout was 1.19 (sexes combined).

TABLE 2. Total catch and catch per unit effort (CPUE) for each species by mesh size from experimental nets, Clearwater Lake, 1979.

Species	77 mm (3")		96 mm(3 3/4")		108 mm (4¼")		121 mm(4 3/4")		133 mm (5¼")		Total	
	No.	CPUE[a]	No.	CPUE[a]	No.	CPUE[a]	No.	CPUE[a]	No.	CPUE[a]	No.	CPUE[a]
Lake trout	34	9.8	42	12.1	28	8.0	23	6.6	31	8.9	158	9.0
Whitefish	183	52.5	141	40.5	102	29.3	43	12.3	27	7.7	496	28.4
Northern pike	12	3.4	7	2.0	4	1.1	1	0.3	3	0.9	27	1.5
White sucker	48	13.8	47	13.5	59	16.9	23	6.6	29	8.3	206	11.8
Longnose sucker	23	6.6	20	5.7	8	2.3	14	4.0	23	6.6	88	5.1
Burbot	6	1.7	4	1.1	2	0.6	-		1	0.6	13	0.7
Total	306	87.8	261	74.9	203	58.3	104	29.8	114	32.7	988	56.6

[a] number of fish per 100 meters of gillnet per 24 hours

TABLE 3. Summary of information on each set location, Clearwater Lake, 1979.

Set Date (D/M/Y)	Location No.	Net Length (meters)	Set Duration (hours)	Water Depth (meters)	Total Catch	Catch Per Unit Effort[a]
23/07/79	1	229	27.0	10 - 11	135	48.8
23/07/79	2	229	26.0	13 - 14	122	49.2
24/07/79	3	229	14.5	20 - 23	142	102.6
29/07/79	4	229	12.5	4 - 4	51	42.8
30/07/79	5	229	22.0	22 - 17	127	60.5
08/08/79	6	229	22.5	9 - 14	57	26.6
09/08/79	7	229	23.0	34 - 32	176	80.2
13/08/79	8	229	12.0	26 - 28	129	112.7
14/08/79	9	229	23.5	11 - 8	49	21.9

[a] number of fish per 100 meters of gillnet per 24 hours

Age Composition

The age-frequency distribution for lake trout is shown in Figure 2 and shows a distribution skewed to the left with age classes 6 to 22 inclusive forming the majority of age classes represented. Details on the age-frequency distribution are given in Table 4. Lake trout from Clearwater Lake had a mean age of 12.6 years and ranged from 2 to 32 years inclusive (N = 295).

Growth

Growth in length and weight for Clearwater Lake lake trout is illustrated in Figure 3. For the growth comparison, only data based on otolith ages were selected. The slope of the length-weight regression line (b = 3.2826) indicates that Clearwater Lake lake trout exhibit a positive allometric growth.

Sex Ratio

The sex ratio (females to males) for lake trout from Clearwater Lake was 0.9 : 1 for the entire sample (Table 4). The data indicates no trends in this ratio with increasing age and both sexes were well represented in most age classes.

Survival

The catch curve for Clearwater Lake lake trout is shown in Figure 4. As a result of the irregularity of the catch curve, a segment analysis as

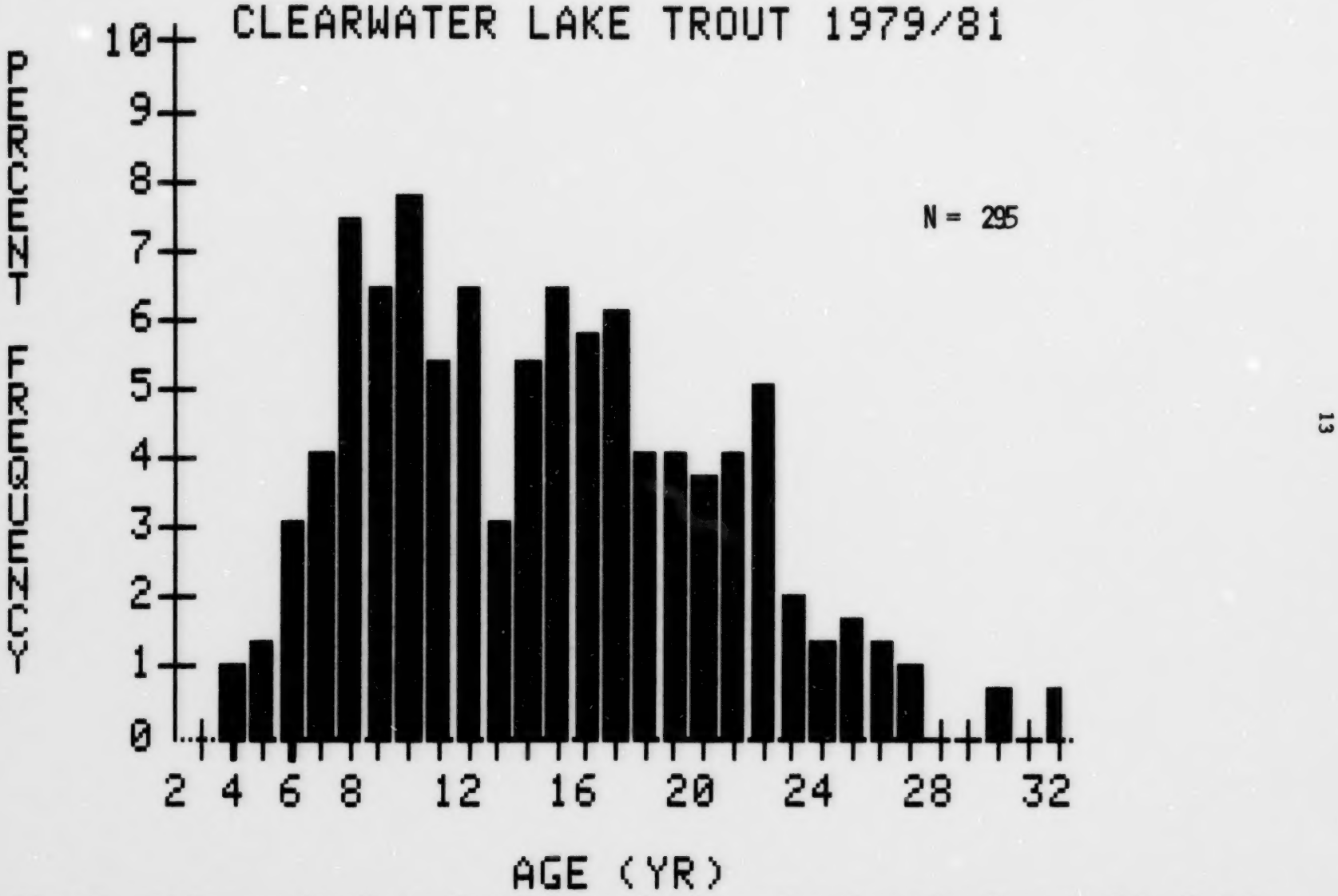

Figure 2. Age frequency distribution for lake trout taken in experimental nets from Clearwater Lake, Manitoba, 1979/81. Ages are determined from otoliths.

TABLE 4. Mean fork length, mean round weight, condition factor and percent females by age for lake trout from experimental nets, Clearwater Lake, 1979 and 1981.

Age (Yr)	No.	Fork Length(mm) Mean	Fork Length(mm) SD	Weight (g) Mean	Weight (g) SD	Condition Factor	No. Males	No. Females	Percent Females
1	-	-	-	-	-	-	-	-	-
2	3	295	76.9	313	225.0	1.11	1	2	67
3	4	333	18.8	363	87.3	.96	2	1	25
4	9	375	56.5	601	264.9	1.06	2	6	67
5	12	472	33.9	1219	312.9	1.13	8	4	33
6	22	478	38.4	1359	317.6	1.22	12	10	45
7	19	501	49.7	1496	399.8	1.17	8	11	58
8	23	502	56.5	1535	531.1	1.17	12	11	48
9	16	531	70.8	1952	1117.4	1.22	11	5	31
10	19	521	35.6	1685	336.3	1.18	10	9	47
11	9	542	23.1	2049	292.5	1.28	4	5	56
12	16	557	54.7	2042	827.4	1.14	9	7	44
13	19	567	71.7	2242	1072.8	1.17	9	10	53
14	17	562	45.6	2171	989.1	1.17	7	10	59
15	18	571	43.7	2264	671.5	1.18	9	9	50
16	12	564	36.1	2183	551.5	1.2	7	5	42
17	12	561	29.9	2116	548.4	1.18	6	6	50
18	11	561	34.1	1938	469.7	1.09	4	7	64
19	12	600	92.1	2803	1679.1	1.16	7	5	42
20	15	594	113.8	3086	3423.3	1.21	8	7	47
21	6	604	87.5	3068	1796.5	1.28	4	2	33
22	4	597	21.	2920	600.2	1.36	2	2	50
23	5	575	23.	2390	461.5	1.24	4	1	20
24	4	617	85.6	3578	2610.6	1.32	3	1	25
25	3	600	69.7	3260	1992.8	1.39	1	2	67
26	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-
28	2	962	47.4	13700	2545.6	1.53	1	1	50
29	-	-	-	-	-	-	-	-	-
30	2	603	67.9	3030	1753.6	1.3	0	2	0
31	-	-	-	-	-	-	-	-	-
32	1	702	0	5800	0	1.68	1	0	0
Total	295						154	141	48
Mean	12.6[a]	537	88.7	2064	1605.1	1.19			

[a] indicates mean age

Length-Weight Regression

Slope: 3.28258289
Y-Intercept: -13.1231547
Correlation Coefficient: .974487813

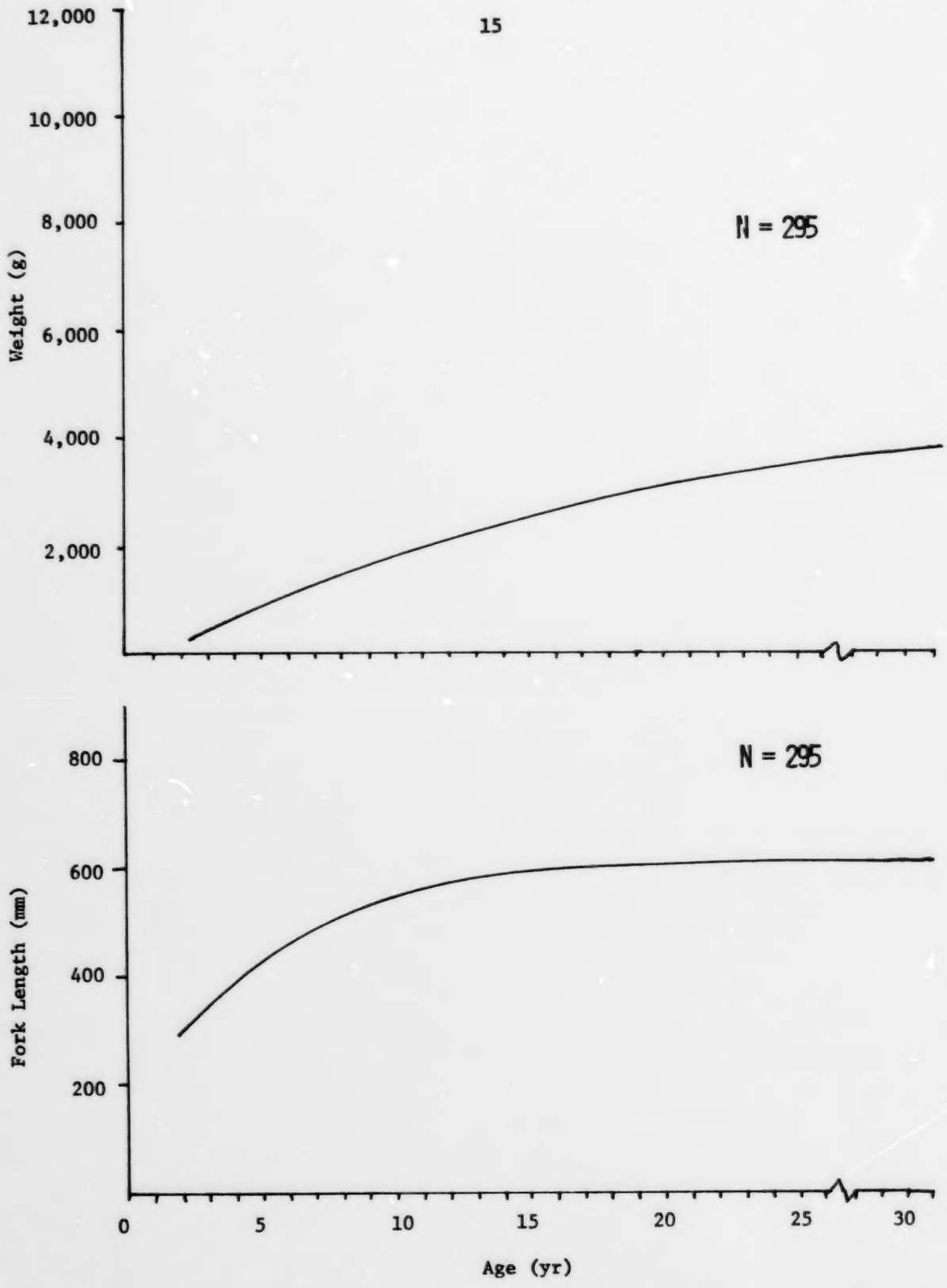

Figure 3. Growth in length and weight for lake trout taken in experimental nets, Clearwater Lake, 1979/81.

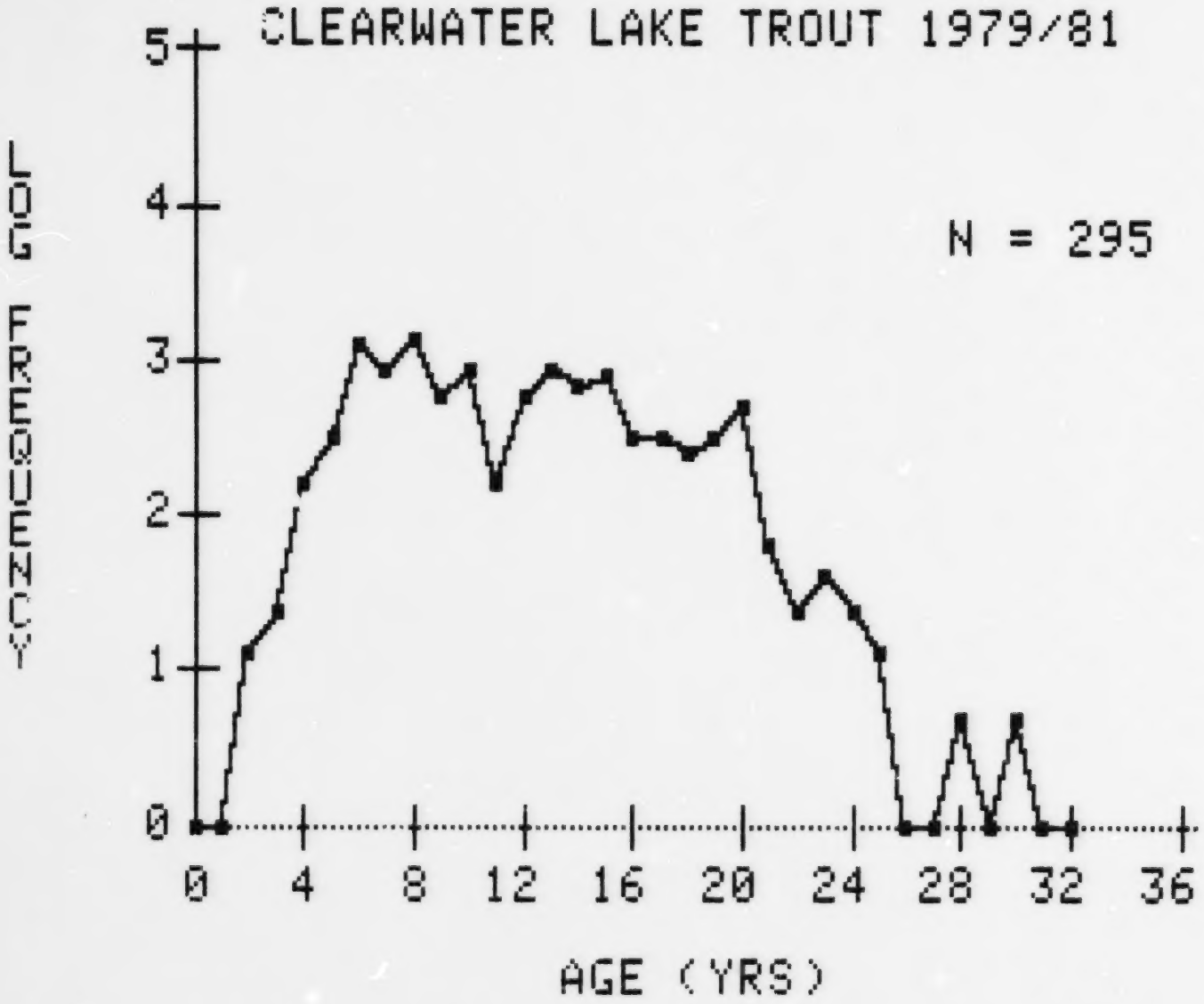

Figure 4. Catch curve for lake trout from Clearwater Lake, Manitoba, 1979/81.

outlined by Robson and Chapman (1961) was used to calculate the survival rate. The estimated survival rate using this method for lake trout was 70% (using ages 20 - 25). The linear regression method applied to the same segment yielded a survival rate of 77%.

PRODUCTIVITY

The mean depth of Clearwater Lake (13.2 m) falls well within the range stated by Ryder et al (1974) as acceptable for calculating the morphoedaphic index (MEI). When the MEI is applied to Ryder's (1965) equation for maximum sustainale yield (MSY), a value of 140,328 kilograms per year is derived. The figure is an annual production for all species, not specifically lake trout.

DISCUSSION

CATCH

Gillnets can obtain a representative sample of a fish population by using a range of gillnets that take overlapping size groups, however there is a tendency for larger mesh sizes to catch fish of a size for which they were selective more efficiently than smaller mesh sizes catch fish for which they are selective. As a result, smaller size classes are usually not well represented in the catch. This selection factor may affect estimates of population characteristics that rely on random sampling, however data used from other studies for comparison purposes were based on similar methods of gillnetting.

The catch per unit effort for lake trout from Clearwater Lake was 9.0 (No./100 m/24 h). Data from Athapapuskow Lake was converted to the same units and ranged from 2.16 to 7.79, with a mean of 5.07 (Day, unpublished). Day's study indicated that the lake trout stocks in Athapapuskow were declining and showing evidence of over-exploitation. Falk (in prep.) reported catch per unit effort data for lake trout from Prosperous and Prelude lakes of 2.5 and 4.4 respectively. Falk concluded from his study that these values were in the low range for Northwest Territories' lakes and that the two lakes were over-exploited. Data from Reed Lake yielded a catch per unit effort of 3.5 and it was concluded that lake trout stocks in Reed Lake were low (Leroux, unpublished). The above comparisons are valid as all data are based on the same units of CPUE and the data was collected with standard gang gillnets of comparable mesh sizes. These comparisons indicate that the relative abundance of lake trout in Clearwater Lake was high when compared to similar lakes which show signs of over-exploitation.

The total catch and relative abundance of each species for this study are similar to Schlick's (1978) results from 1970. The comparison of relative abundance between 1970 and 1979 is shown in Table 5. Although there has been some shifts of relative abundance among various species between surveys the percentage of non-sport species represented in the catch remained identical; eighty one percent (Table 5). Lake trout showed a small decrease from the 1970 survey.

TABLE 5. Comparison of total catch and catch per unit effort (No./100 yd) of all species from experimental nets, Clearwater Lake, 1970 and 1979.

Species	[a]1970			1979		
	No.	%	No./100 yd.	No.	%	No./100 yd.
Whitefish	369	44.0	16.4	496	50.2	22.0
Lake Trout	178	21.1	7.9	158	16.0	7.0
Northern Pike	7	0.8	0.3	27	3.0	1.2
White Sucker	142	16.9	6.3	206	20.9	9.2
Longnose Sucker	136	16.2	6.0	88	8.9	3.9
Burbot	8	1.0	0.4	13	1.3	2.9
Total	840		37.3	988		43.9
Non-sport Species	81.9%			81.3%		

[a]data from Schlick, 1970

Lake trout to whitefish ratios provide a good index of relative abundance as both species occupy a similar habitat, therefore species selectivity by set location is not a factor. A comparison of lake trout to whitefish ratios from Clearwater Lake to other studies is presented below:

Location	Ratio (trout to whitefish)
Clearwater Lake, 1970	.48 : 1
Clearwater Lake, 1979	.32 : 1
Prosperous Lake, 1973/79	.20 : 1
Athapapuskow Lake, 1977-78	.16 : 1
Keller Lake, 1962	.85 : 1
Reed Lake, 1980-81	.16 : 1

The above data indicates that while lake trout stocks in Clearwater Lake have declined since 1970, they are still more abundant in relative terms than lakes determined to be over-exploited (Athapapuskow and Prosperous lakes) yet below those values reported for relatively unexploited lakes (Keller Lake).

LAKE TROUT

Condition factors describe the length-weight relationship or relative robustness of a fish. The condition factor will vary depending on gonadal condition, fullness of the gut, fat reserves and the degree of muscular

development. Clearwater Lake trout exhibited condition factors similar to those of lake trout from Reed Lake (Leroux, unpublished) and other selected lakes in the Northwest Territories (Moshenko, 1980) indicating a similar quality of environment in these oligotrophic lakes. The results also indicated that condition factors increased with increasing size of fish.

The age-frequency distribution shown in Figure 2 illustrates a distribution skewed to the left. The mean age of the sample was 12.6 years and lake trout past the age of 22 years were poorly represented in the sample. Variations in year class strength are likely sampling artifacts and probably do not reflect weak year classes. The absence of younger aged fish (age 5 and younger) can be attributed to the gear. As discussed previously, gillnets tend to be more effective on larger fish therefore the histogram illustrated does not truly represent younger year class strengths. The absence of older "trophy" size trout is likely a result of over-exploitation of this segment of the population. The mean age of 12.6 years for this study is higher than the mean age of 7.6 reported by Schlick (1978), however Schlick's ages were based on scale ages which studies have shown tend to underestimate the ages of older lake trout. The mean age reported by Schlick would therefore be higher and likely fall closer to the mean age found in the present study, indicating that there has not been a significant change in the mean age.

Lake trout growth in Clearwater Lake is compared to growth of lake trout in other selected lakes from Manitoba and the Northwest Territories

in Figure 5. The elevation of the curve indicates that growth in the early years is near the maximum found by Healey (1978) throughout the normal range of lake trout growth, however the curve begins to flatten at a relatively early age and reaches an asymtotic growth at approximately age 16. Growth in the older age classes may not be representative as these age classes are not well represented in the sample. An examination of tag return data for Clearwater Lake indicated a mean growth in length of 10 millimeters per year (range 3.8 to 19.0 mm). These data are based on 19 tag returns where fork lengths were taken during tagging and again on recapture. The interim between tagging and recapture for the 19 samples ranged from 8 to 13 years.

Reasons for the slow growth in Clearwater Lake are not clearly evident. It may be due in part to environmental conditions as Clearwater Lake is a large open deep lake and maintains a much colder temperature than other lakes in the region. The dramatic decrease in growth in the older age classes may also be attributed to prey species. Ciscoes are not a common species in Clearwater Lake as indicated in the netting results. Only one ciscoe was taken in the 1979/81 netting compared to over 50 percent ciscoes reported in the experimental netting of Reed Lake (Leroux, unpublished). The lake trout of Reed Lake exhibited similar growth in the younger age classes as that of Clearwater Lake, however did not reach an asymtotic growth rate (Figure 5). The lack of easily available prey may result in the lake trout expending greater amounts of energy in obtaining food than lake trout populations where food is more readily available.

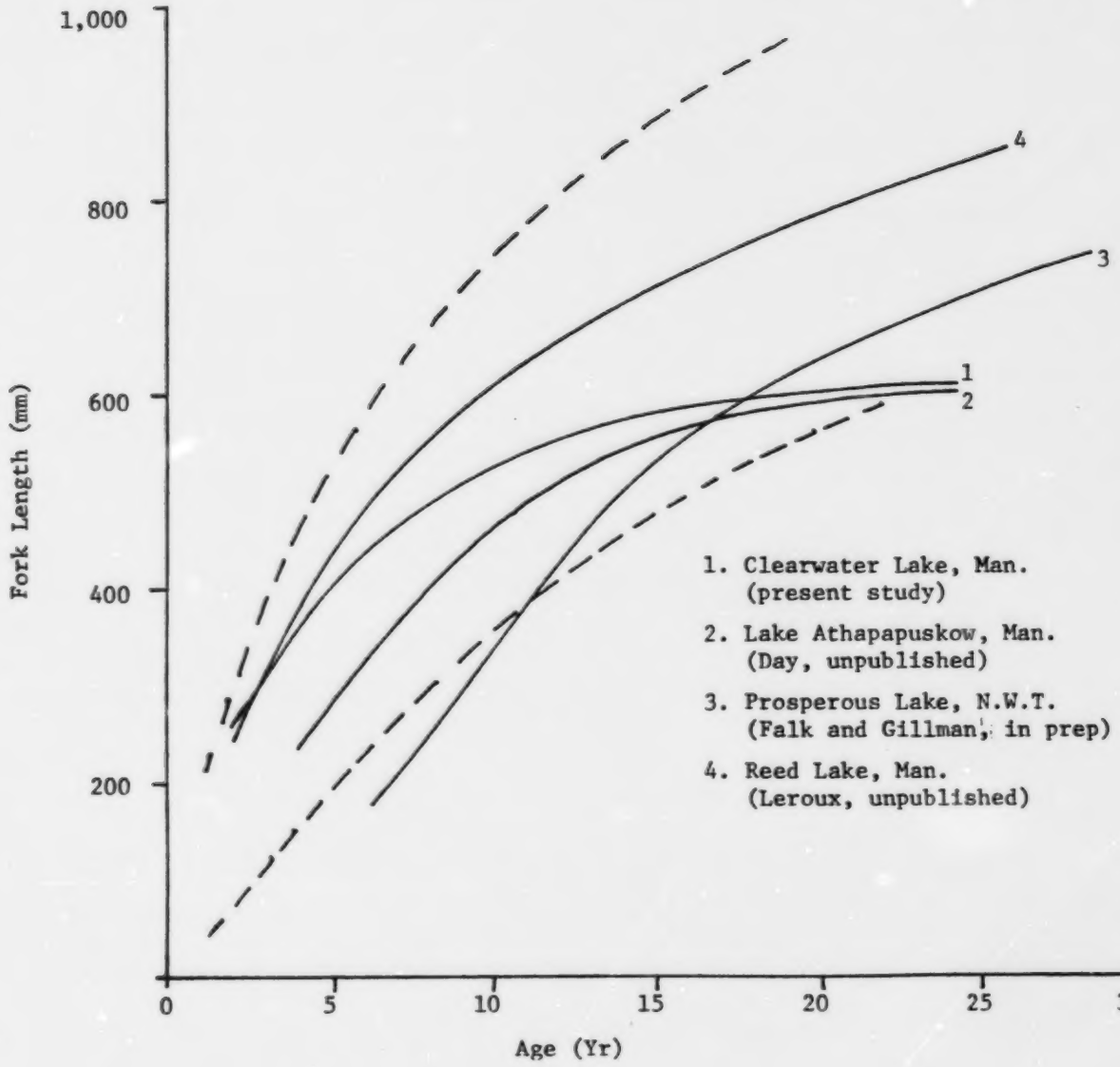

Figure 5. Comparison of lake trout growth from Clearwater Lake, Manitoba to other lakes in Manitoba and the Northwest Territories (based on otolith ages). Dashed lines indicate the range of observed lake trout growth (Healey, 1975).

Mortality estimates based on analysis of the catch curve (Figure 4) indiated that mortality falls somewhere between 23 and 30 percent annually. As there are inherent errors in determining the ages of older lake trout, generally in underageing, then the estimates of mortality are likely too high. Based on this, the mortality rates of trout from Clearwater Lake fall within the range of natural mortality (17 to 36 percent) as stated by Healey (1978). Healey stated that under exploitation, some lake trout populations may be able to withstand an additional 30 to 40 percent fishing mortality for a total mortality of about 50 percent annually. Populations showing mortality in excess of 50 percent annually were all in serious trouble and rapidly declining.

The maturity data for lake trout from Clearwater Lake indicates that the population reaches full sexual maturity at approximately age 8. Maturity data were collected only during the additional netting done in 1981 and these data are presented in Table 6. Schlick (1980) reported the youngest spawning age for lake trout from Clearwater Lake as age 4+ but suggested that scale ages were underestimated by 3 to 5 years. Thus, the age was more likely in the range of 7 to 9 years. Schlick also stated from his tagging study that known age lake trout were first caught as spawners in the fish culture trap nets at age 7.

Males appear to reach sexual maturity at an earlier age than females as the males reached 100 percent sexual maturity at age 6 as opposed to age 8 for females. The maturity data presented in Table 6 would also support the conclusion that spawning does not occur every year once an

TABLE 6. MEAN FORK LENGTH. MEAN ROUND WEIGHT. CONDITION FACTOR. MATURITY. AND PERCENT FEMALES BY AGE FOR LAKE TROUT FROM EXPERIMENTAL NETS. CLEARWATER LAKE. 1981.

AGE		FORK LENGTH (MM)		WEIGHT (G)		CONDITION	MALES		FEMALES		PERCENT
(YR)	NO.	MEAN	SD	MEAN	SD	FACTOR	NO.	% MATURE	NO.	% MATURE	FEMALES
1	-	-	-	-	-	-	-	-	-	-	-
2	3	295	76.9	313	225	1.11	1	0	2	0	67
3	3	340	15.2	397	66.6	1	2	50	1	0	33
4	6	392	63.2	702	273.6	1.09	2	100	4	0	67
5	11	474	34.8	1247	311.9	1.15	8	75	3	33	27
6	13	497	27.2	1485	263.2	1.2	7	100	6	33	46
7	9	521	46.3	1703	347.3	1.2	6	100	3	67	33
8	11	529	47.3	1819	553.5	1.2	9	100	2	100	18
9	10	548	86	2203	1373.8	1.23	6	100	4	75	40
10	3	558	8.5	2067	122.2	1.19	3	0	0	0	0
11	5	555	16.4	2198	197.8	1.28	3	100	2	100	40
12	5	573	73.4	2386	1164.9	1.21	3	100	2	50	40
13	8	590	80	2533	1229	1.18	6	100	2	100	25
14	5	574	52.8	2170	717.6	1.12	1	100	4	75	80
15	8	561	32.4	2118	475.3	1.18	5	100	3	100	38
16	4	572	52.5	2450	691.6	1.29	2	100	2	100	50
17	4	571	36.4	2328	889.6	1.21	1	100	3	100	75
18	5	574	24.4	2172	349.5	1.15	2	100	3	100	60
19	6	589	99	2802	1534.4	1.25	5	100	1	100	17
20	7	563	59.8	2220	743.7	1.21	4	100	3	33	43
21	4	625	95.4	3383	2134.9	1.27	2	100	2	100	50
22	1	600	0	2900	0	1.34	1	0	0	0	0
23	5	575	23	2390	461.5	1.24	4	100	1	100	20
24	1	648	0	4360	0	1.6	1	0	0	0	0
25	3	600	69.7	3260	1992.8	1.39	1	100	2	50	67
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	2	962	47.4	13700	2545.6	1.53	1	100	1	100	50
29	-	-	-	-	-	-	-	-	-	-	-
30	2	603	67.9	3030	1753.6	1.3	0	0	2	0	0
31	-	-	-	-	-	-	-	-	-	-	-
32	1	702	0	5800	0	1.68	1	0	0	0	0
TOTAL	145						87	95	58	66	40
MEAN	12.4 ^	541	98.8	2193	1759.3	1.21					

^ INDICATES MEAN AGE

LENGTH-WEIGHT REGRESSION

SLOPE: 3.27418785
Y-INTERCEPT: -13.0507648
CORRELATION COEFFICENT: .984847538

individual fish reaches sexual maturity as not all age classes showed one hundred percent mature for age classes beyond age 8. Schlick (1980), based on tag returns, also concluded that lake trout from Clearwater Lake did not spawn every year once reaching sexual maturity. Day (1983) also determined that lake trout in Athapapuskow Lake do not spawn each year. Some caution should be exercised in assessing these results as the degree of sexual development is difficult to assess several months prior to spawning.

PRODUCTIVITY

The annual production for all species from Clearwater Lake is 140,328 kg/yr based on Ryder's (1965) equation for maximum sustainable yield. Ryder's equation was based on data that included the total weight of all species harvested by angling, commercial and domestic fishing. As Clearwater Lake is restricted to angling, some adjustment to the MSY is necessary. The prime concern on Clearwater Lake is the harvest of lake trout and what harvest rates the lake is capable of supporting. As lake trout comprised 15.9 percent of all species caught, applying this figure to the total annual production of all species, yields an annual lake trout harvest of 22,300 kg/yr. Healey (1978) examined data from North America and concluded that yields of lake trout are not sustainable when harvests exceeded 0.5 kg/ha. Healey's maximum yield then for Clearwater Lake, using this figure, would be 14,437 kg/yr.

A review of the above estimates for the annual yield from Clearwater

Lake would indicate that the maximum sustainable angling yield for lake trout would lie between 14,000 to 22,000 kilograms annually (figures rounded off). It is unknown what the present harvest rates are on Clearwater Lake, however a creel census in 1970 estimated the angler harvest at 12,700 kilograms for the open water period. Winter angling is a prime recreation at Clearwater Lake and this harvest was not included in the survey, therefore the angler harvest would be higher than this figure.

MANAGEMENT IMPLICATIONS

The results of the study indicate that lake trout stocks in Clearwater Lake are healthy but that older larger fish are not well represented in the population. The poor representation of larger trout can be attributed to the nature of the lake trout resource and the users of the resource. As discussed previously, the lake trout in Clearwater Lake are slow growing, particularly in the older age classes. In addition, these trout exhibit a late age of maturity and may not spawn each year. Lake trout are generally not abundant in any of their habitats (Healey, 1978). In contrast, the number of resource users is comparatively large and is growing at an increasing rate.

The present rate of exploitation is likely keeping recruitment of these older fish to a minimum. It is unlikely that the stocks will ever recover to a trophy fishery status without the implementation of rigid restrictions on harvest rates over a lengthy period of time. Even with such control, recovery of trophy status is not guaranteed as lake trout

have a limited ability to respond to angling pressure (Healey, 1978). In addition, such an attempt to recreate a trophy fishery would be unrealistic in light of present lake development and angling demand. It is desireable however, to maintain the present high quality angling and the healthy level of trout stocks.

If required at a future date, changes to the present management strategy for Clearwater Lake must be carefully reviewed due to the lakes present development and status. Clearwater Lake supports lodges, campgrounds and cottages as well as itinerant use. Although other angling opportunities are available, Clearwater Lake is used extensively by local area residents. Severe restrictions on angling may have both social and economic repercussions. In light of these considerations, further reductions in catch and possession limits or non-resident restrictions may not be feasible alternatives in future management strategies. The expansion of seasonal and area closures may provide the least disruptive and most acceptable impact on present user groups should changes be required to present lake management.

In addition to these future alternatives, consideration should be given to establishing a moratorium on further fisheries based development on Clearwater Lake. Trophy qualities of the lake have been severely reduced and trout stocks, although remaining healthy, show signs of other exploited populations. In view of the sensitive nature of trout stocks, the resulting difficulties in management and their slow recovery response a freeze on present fisheries based facilities would provide an important,

initial step in ensuring that the present high quality angling is maintained for future years.

RECOMMENDATIONS

1. A continuation of the present, temporary moratorium on fisheries based lake development until the magnitude of the angler harvest is determined through a lake creel census. In addition to determining the total angler harvest on an annual basis, such a census should identify the user groups and the level of resource harvest which can be attributed to each group.

2. Additional or expanded seasonal and area closures be considered for Clearwater Lake if harvest rates be determined to exceed 0.5 kg/ha.

3. Due to the importance of this fishery and sensitive nature of trout stocks, a follow up study be carried out in ten years to monitor the effects of present exploitation on stocks and assess effectiveness of management strategies.

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to B. Wright and A. Clark for conducting the field work in 1979. B. Bruederlin assisted with the field work in 1981.

Appreciation is expressed to all Department staff involved in ageing

of structures. J.F. O'Connor, B. Wright and D. Toews provided criticism and suggestions on the manuscript.

Thanks are extended to C. Gray and K. Bulloch for an excellent job in typing the manuscript.

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